FINITE ELEMENT ANALYSIS IN OFFSHORE PIPELINE APPLICATIONS LINEAR ELASTIC DEVELOPMENT

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ABSTRACT:
Internal pressure ratings and pipeline wall thickness design calculations in the ASME B31.4 [1] and B31.8 [2] Codes are based on the maximum principal stress theory of failure, primarily using Barlow's equation. The current editions of these pipeline Codes do not provide for a detailed numerical analysis approach (such as finite element analysis) for their components. The pipeline Codes either point to the ASME B&PV Code, Section VIII, Division 2 (Division 2) [4] or there is a reference to Division 2 from the Code of Federal Regulations [5, 6].

An FEA approach using the methods provided in Division 2 can be used to assess the structure integrity of pipeline components. When this approach is based on a linear elastic analysis with stress linearization, a single value of stress limit needs to be found. Such a stress limit should have same design margin as that used in the pipeline Codes [1, 2].

In this paper, a stress limit based on the von Mises equivalent stress theory is established for pipelines subjected to internal pressure. This stress limit has an equivalent value of design margin. Both closed-end and open-end conditions are considered. The single value stress limit can be derived by classical hand calculations. Stress limits for loadings other than internal pressure that are required by the pipeline Codes for compliance are beyond the scope of this paper.

Two application examples are given showing studies done with FEA and ABAQUS software [3]. A stress limit is established using classical hand calculations and verified by a simple finite element model. The linearized stresses at critical locations are then compared to the stress limit, and multiples depending on classification, for the assessments of membrane and membrane plus bending stresses.

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